

REPORT DOCUMENTATION PAGE			Form Approved OMB No. 0704-0188	
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.				
1. AGENCY USE ONLY (Leave Blank)	2. REPORT DATE 19May99	3. REPORT TYPE AND DATES COVERED Final Technical Report: 01MAY97-30NOV98		
4. TITLE AND SUBTITLE PCIS-2: Distributed Component-based Software Engineering		5. FUNDING NUMBERS N00014-97-1-0872		
6. AUTHORS Timothy E. Lindquist				
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Arizona Board of Regents Arizona State University, Office of Research and Creative Activities P.O. Box 871603 Tempe, AZ 85287-1603		8. PERFORMING ORGANIZATION REPORT NUMBER		
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) Office of Naval Research Ballston Tower One 800 North Quincy Street Arlington, VA 22217-5660		10. SPONSORING / MONITORING AGENCY REPORT NUMBER		
11. SUPPLEMENTARY NOTES		19990528 039		
12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution is unlimited.		12b. DISTRIBUTION CODE		
13. ABSTRACT (Maximum 200 words) ASU received funds on this effort to contribute to the PCIS-2 joint USA and France Technology Research and Development Project (TRDP). PCIS-2 (Portable Common Interface Set) is a three phase project whose goal is to develop a distributed software engineering environment primarily from commercial off-the-shelf tools, government owned tools, current distributed object technology (WWW, Java and CORBA, for example) and the technology developed in the PCIS program. Phase-I of the project developed architecture for PCIS-2, selected a set of tools and created prototype implementation approaches. Phase-II includes realization of the architecture and wrapping of selected tools. Phase-III provides for usage and evaluation of the resulting environment. When software development is distributed (software engineers are geographically dispersed), cooperation among engineers in jointly producing software artifacts (source code, and associated information) becomes an important issue. The PCIS-2 Architecture includes distributed object services for software process definition and enactment, as well as services for distributed configuration management and fine-grained traceability among software artifacts. These services are being realized in the PCIS-2 Phase-II, together with the wrapping of several commercial tools to utilize the services. ASU has all supported realization of the process services.				
14. SUBJECT TERMS PCIS software engineering configuration management			15. NUMBER OF PAGES 4	
			16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT UL	

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. Z39-1
298-102

DTIC QUALITY INSPECTED 4

PCIS-2: Distributed Component-Based Software Engineering

**Final Report to SSC San Diego and
The Office of Naval Research**

ONR Award Number:

N00014-97-1-0872

By Timothy E. Lindquist

Computer Science and Engineering

Arizona State University

Tempe, Arizona 85287-5406

Lindquist@asu.edu

Phone: (480) 965-2783

Fax: (480) 965-2751

May 19, 1999

For Contracting Questions Please Contact:

Ms Laura Roggenbauer

ASU Research and Sponsored Programs (Preaward Services)

Tempe, Arizona 85287

(602) 965-0029

1.0 Introduction

ASU received funds on this effort to contribute to the PCIS-2 joint USA and France Technology Research and Development Project (TRDP). PCIS-2 (Portable Common Interface Set) is a three phase project whose goal is to develop a distributed software engineering environment primarily from commercial off-the-shelf tools, government owned tools, current distributed object technology (WWW, Java and CORBA, for example) and the technology developed in the PCIS program (see [11.]). Phase-I of the project developed an architecture for PCIS-2 (see [8.]), selected a set of tools and created prototype implementation approaches. Phase-II includes realization of the architecture and wrapping of selected tools. Phase-III provides for usage and evaluation of the resulting environment.

When software development is distributed (software engineers are geographically dispersed), cooperation among engineers in jointly producing software artifacts (source code, and associated information) becomes an important issue. The PCIS-2 Architecture includes distributed object services for software process definition and enactment, as well as services for distributed configuration management and fine-grained traceability among software artifacts. These services are being realized in the PCIS-2 Phase-II, together with wrappings of several commercial tools to utilize the services.

ASU has also supported realization of the process services.

2.0 Project Technical Accomplishments and Reports

ASU has contributed to the formulation of the PCIS-2 architecture, principally in the process services area. This work has included cooperation with the French academic project partner (LORIA Nancy France) who is responsible for the architecture definition. ASU has also participated with SSC San Diego in background exploration and realization of the process services. The funds provided by the contract have also supported participation in the PCIS-2 project meetings.

2.1 PCIS-2 Process Components

Software components present a new paradigm for composing, reusing and configuring desktop functionality. But, what can be done to take advantage of these approaches short of rewriting legacy tools? The approach of this project is to provide key software engineering services as network available components. Legacy tools are wrapped to provide the services where ever possible. Further, legacy tools are wrapped to utilize the services.

When software is constructed by a widely distributed work group, process coordination and cooperation become central issues. Existing workflow and automated process tools provide considerable functionality to address coordination problems, but generally assuming limited distribution of participants. Several issues become more complex when a software project and personnel are distributed over a wide area network of heterogeneous workstations. These issues are:

- Who is responsible for producing each of the different software artifacts,

- How can the products produced by heterogeneous tools running on diverse platforms be integrated into a single software system,
- How can we coordinate the workers and tool components producing the artifacts,
- How can we coordinate distributed teams working under their own guidelines and best practice conventions to contribute to a single software project, and
- How do each of the software artifacts relate to other project artifacts?

Automated support for workflow resolves these issues by defining the activities that are performed in a software development, by tracking the status of each activity as it progresses and by overseeing the use of tools to produce software artifacts. Under PCIS-2, we have defined a set of services aimed at interoperability among software process tools. The approach has been defined and we are currently continuing prototype activities. Various aspects of our approach has been reported in several papers and reports (see [1.]), (see [2.]), (see [6.]), (see [7.]), (see [9.]), and (see [10.]).

PCIS-2 identifies a set of process definition and enactment services that can realized by wrapping existing process tools. The wrappings present process definition, enactment and analysis components to the internet for use by other (process and non-process) tools. PCIS-2 Process Components (see [8.]) facilitate a single software process that includes subprocesses that are defined or enacted using distributed heterogeneous process tools. Our current prototype activities include wrapping Fujitsu's workflow product, i-Flow.

3.0 Fiscal Report

3.1 Personnel

The project has supported 2 graduate research assistants, Ph.D. students Kevin Gary and Ly Sauer, 1 post-doctoral researcher, Dr. Harry Koehnemann, and 1 faculty principal investigator, Dr. Tim Lindquist. Kevin Gary (see [4.]) and Ly Sauer (see [5.]) have completed the requirements for the Ph.D. in Computer Science and Engineering in Spring 1999. Kevin is now an Assistant Professor at The Catholic University of America and Ly is a member of the technical staff at Sandia Laboratory.

3.2 Travel and Other Expenditures

The project has supported participation of all researchers in Joint French and USA project formulation and technical meetings, as hosted by SSC in San Diego, LORIA and the French MOD at various locations in France.

The project has also supported several software purchases. Currently, the project is using the i-Flow workflow tool, produced by Fujitsu Software Corporation to realize the project process services.

4.0 References

- [1.] "An Open Framework for Software Process Components," submitted ASE 99, (Gary, K; Lindquist, T; Koehnemann, H; Derniame J.C.) March 1999.
- [2.] "Cooperating Process Components," to appear Proc. CompSAC '99, (Gary, K; Lindquist, T) October 1999.
- [3.] "Distributed Architectures for Process Component Support " (Gary, K; Lindquist, T) accepted for presentation at the WORLD MULTICONFERENCE SCI/ISAS'99, International Workshop on Process support for Distributed Team-based Software Development (PDTSD'99), to be held in Orlando, USA, from July 31 to August 4, 1999.
- [4.] "Open Process Components," Gary, Kevin A., Ph.D. Dissertation, Computer Science and Engineering, Arizona State University, Tempe Arizona, May 1999.
- [5.] "Brokering Process Components," Sauer, Ly D., Ph.D. Dissertation, Computer Science and Engineering, Arizona State University, Tempe, Arizona, May 1999.
- [6.] "Brokering Software Process Components," submitted IEEE Computer, (Sauer, L; Lindquist, T) November 1998.
- [7.] "Component-Based Software Process Support", Short paper in Proc. ASE 98, (Gary, K., Lindquist, T., Koehnemann, H., Derniame J.C.) October 1998.
- [8.] The US-France Technology Research and Development Project, "*PCIS2 Architecture Specification Version 1.0*", (Lindquist, TE editor) SPAWAR Systems Command, San Diego CA, January 1998
- [9.] "Automated Process Support for Organizational and Personal Processes, Proc. ACM SIG-GROUP Group '97 Conference (Gary, KA; Lindquist, TE; Sauer, LD; and Koehnemann HE), pp. 221-230, November 1997.
- [10.] "Towards Distributed and Composable Process Components" in Proc. 6-th European Software Process Workshop 1997, (Lindquist, TE and Derniame J-C), July 1997.
- [11.] PCIS Architecture: Framework Definition and Rationale, Version 1.0; NATO Tri-Service Group on Communications and Electronics, Special Working Group on Ada Programming Support Environments, 31 December, 1993.
- [12.] PCTE, Portable Common Tool Environment (ISO and ECMA Standard), European Computer Manufacturers Association, 114 Rue du Rhone, CH-1204, Geneva, Switzerland. Tel: +41 22 735 36 34, Fax: +41 22 786 52 31.